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THE DEVELOPMENT OF ACHIEVEMENT MEASURES FOR TRADE AND TECHNICAL EDUCATION. PROGRESS REPORT NUMBER FOUR.

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DURING THE FIRST YEAR OF THE PROJECT, TO DISCOVER MORE ADEQUATE WAYS OF MEASURING IMPORTANT TACTILE-KINESTHETIC MODALITIES, APPROXIMATELY 40 INSTRUCTORS WITHIN THE NORTH CAROLINA DEPARTMENT OF COMMUNITY COLLEGES AND TECHNICAL INSTITUTES, WORKING WITH PROJECT STAFF MEMBERS, COMPLETED A CURRICULUM ANALYSIS FOR THE TECHNICAL OR TRADE SPECIALITY IN EACH OF THE SEVEN AREAS FOR WHICH TESTS ARE BEING DEVELOPED AND COMPILED A POOL OF FROM 500 TO 800 TEST ITEMS FOR EACH CURRICULUM. THESE ITEMS WERE CONSTRUCTED TO REPRESENT EACH TOPIC INTO WHICH EACH CURRICULUM HAD BEEN DIVIDED, AND THE 4 LEVELS OF CLASSIFYING EDUCATIONAL OBJECTIVES WHICH WERE ACCEPTED BY THE PROJECT STAFF--KNOWLEDGE, UNDERSTANDING, AND TWO LEVELS OF APPLICATION. PAPER AND PENCIL TESTS WERE COMPLETED IN ELECTRONICS TECHNOLOGY AND ELECTRONICS DATA PROCESSING TECHNOLOGY. TWO ANALOGOUS FORMS OF THE TEST IN EACH TECHNICAL AREA WERE DEVELOPED, AND ITEM AND FACTOR ANALYSES WILL DETERMINE THE MOST APPROPRIATE ITEMS FOR EACH FORM OF THE FINAL TESTS. PAPER AND PENCIL TESTS AND PERFORMANCE TESTS IN THE OTHER FIVE AREAS ARE IN THE PROCESS OF DEVELOPMENT. STANDARDIZED DATA FROM STUDENT RECORDS IS TO BE STUDIED TO DETERMINE ITS RELATIONSHIP TO ANY OF THE FACTORS OF ACHIEVEMENT IDENTIFIED THROUGH FACTOR ANALYSES. AN EXPERIMENTAL SECTION ESTABLISHED WITHIN THE PROJECT WILL CONDUCT BASIC INVESTIGATIONS CONCERNING THE AUDITORY, VISUAL, KINESTHETIC, AND OLFACTORY SENSES. THIRTY INSTITUTIONS, REPRESENTING OVER 95 PERCENT OF THE TOTAL NORTH CAROLINA ENROLLMENT IN EACH OF THE SEVEN AREAS, HAVE AGREED TO PARTICIPATE IN THE PROJECT. THE PROJECT HAS BEEN COMPLETELY STAFFED, AN ADVISORY COMMITTEE HAS BEEN FORMED, AND SEVERAL NATIONALLY KNOWN CONSULTANTS HAVE BEEN SECURED FOR THE PROJECT. OTHER PROGRESS REPORTS ARE VT 003 315, VT 003 699, VT 005 199, AND VT 005 200. (HC)

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# SUMMARY OF PROGRESS REPORT NO. 4

During the first year of the project an advisory committee was formed; the project was completely staffed; several nationally known consultants were secured; approximately 40 instructors were employed on a part-time basis as field consultants; preliminary forms of achievement tests were assembled; some basic research in components of performance was done; some performance measuring instruments were developed; and several states were contacted about participation in the research project.

Approximately 40 instructors within the N. C. Department of Community Colleges and technical institutes were employed on a part-time basis as field consultants in the seven technical and trade areas for which the Achievement Measures Project is developing achievement tests. These instructors, working with project staff members, did a curriculum analysis within the technical or trade specialty in each of the seven areas as a prelude to the development of a pool of test items from which preliminary forms of achievement tests could be assembled. The curriculum analysis completed, a pool of test items of from 500 to 300 items for each curriculum was developed. These items were constructed to represent each topic into which each curriculum had been divided, and at the same time to be representative of the four different levels of learning and behavioral objectives as agreed upon by the staff.

Paper and pencil tests have been printed and are ready for spring administration in Electronics Technology and in Electronics Data Processing Technology. Two analogous forms of the test in each area have been developed. Pencil and paper tests and performance tests in the five trade areas are in the process of development, and will be ready for late spring administration.

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PROGRESS REPORT
NUMBER FOUR

# THE DEVELOPMENT OF ACHIEVEMENT MEASURES FOR TRADE AND TECHNICAL EDUCATION

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During the first year of the project, many advancements toward the final goals were made. An advisory committee was formed; the project was completely staffed; several nationally known consultants were secured; approximately 40 instructors were employed on a part-time basis as field consultants; new and adequate quarters for the project were obtained; preliminary forms of achievement tests were assembled; some basic research in components of performance was done; some performance measuring instruments were developed; and several states were contacted about participation in the research project.

By the end of the first project year, approximately 40 instructors within the North Carolina Department of Community Colleges and Technical Institutes had been employed on a part-time basis as field consultants in the seven technical and trade areas for which the Achievement Measures Project is developing achievement tests. These instructors, working with project staff members, did a curriculum analysis within the technical or trade specialty in each of the seven areas as a prelude to the development of a pool of test items from which preliminary forms of achievement tests could be assembled. The curriculum analysis completed, a pool of test items of from 500 to 800 items for each curriculum was developed. These items were constructed to represent each topic into which each curriculum had been divided, and at the same time to be representative of the four different levels of learning and behavioral objectives as agreed upon by the staff. As presented in a previous project report, the staff decided upon a modification of the Taxonomy of Educational Objectives as being most suitable to our needs in classifying educational objectives. The four levels of classification finally accepted by the project staff are: knowledge, understanding, and two levels of application. Operational definitions of these levels of classification have also been included in a prior progress report.

Using the above outlined guidelines and procedures, paper and pencil tests have been completed and are ready for spring administration in Electronics Technology and in Electronics Data Processing Technology. In order to examine a maximum number of items, two analogous forms of the test in each area have been developed. Future item and factor analyses will determine the most appropriate items from each form to be used on the final form of each test. Pencil and paper tests and performance tests in the five trade areas are in the process of development, and will be ready for late spring administration.

To date, 30 institutions within the North Carolina Department of Community Colleges which offer trade and/or technical programs have agreed to participate in the research project. These 30 institutions represent well over 95 percent of the total North Carolina enrollment in each of the seven curricula. Several other states have been contacted and have agreed to participate in the research effort. Nine of the ten South Carolina Technical Education Centers have agreed to participate in the project, and the tenth institution is expected to do so as soon as contact with its administration can be made. Samples from several other states have been solicited. States within which preliminary contacts have been made are: Connecticut, Massachusetts, Delaware, Florida, Georgia, Wisconsin, Virginia and California. We feel that within these aforementioned states a sufficient representative sample will be available for a thorough evaluation of preliminary forms of the achievement measures.

As mentioned in a previous progress report, much thought and discussion was directed toward evaluation of the data gathered during the first administration of the achievement measures. It was decided that a complete item analysis for each item on each test should be done. This analysis will include an evaluation of an item's relationship to the total score of the test, the

total score of the subtest to which it belongs and to all other subtests on the test. Item difficulty and effectiveness of distractors will also be examined. A factor analysis will also be done on each test in order to determine the actual number of factors being measured. In order to identify the factors isolated through factor analysis, it was decided that several short tests which measure relatively pure factors of intelligence should be administered along with the achievement tests. A thorough examination of tests available led to the selection of a battery of research instruments titled "Reference Tests for Cognitive Factors." These tests were developed by Educational Testing Service in cooperation with the U. S. Office of Naval Research. Some of the most reputable people in testing research participated in the development of the reference kit which was designed for use in factorial studies. Each test in the kit is designed to be as pure as possible a measure of a single factor in the cognitive area. The kit contains tests which measure 24 different cognitive factors, and the tests are relatively short, ranging from three to 20 minutes in length. The project staff, in consultation with subject matter specialists and other consultants, has selected from five to eight of these tests for administration with each of our achievement tests. Tests were selected based upon the expert judgment that the cognitive factors measured by the respective tests contributed to achievement in a given trade or technology.

Another approach to the identification of factors which contribute to achievement is also being employed by the project staff. Each institution participating in the research project uses certain criteria for the admission of students to a given trade or technology. The project staff is collecting

all standardized information available from student records to determine the relationship of this data to any of the factors of achievement identified through factor analysis. Among the data of this type which will be evaluated are standardized scores on: General Aptitude Test Battery; Differential Aptitude Test Battery; School and College Ability Test, and College Entrance Examination Board Scores. Other criteria which will be examined are: high school rank; size of high school; previous trade or technical training; age; marital status; and occupation of near relatives. The staff is confident that the relationship of certain of these data to achievement will aid in the development of achievement measures and at the same time be of benefit to the participating institutions in terms of student recruitment and selection.

On February 1, the Achievement Measures Project moved into new quarters. The project has approximately 3,000 square feet of floor space which includes ample office space for staff members, adequate space for graduate assistants, a small shop facility and two rooms which are being used for experimentation in the psychomotor skills.

During the first year of operation, several consultants were brought in to work with the project staff. These included: Dean Rupert N. Evans, Dr. Robert F. Lockman and Dr. Norman E. Stander.

At the beginning of the project, a thorough search of the literature was done in the area of performance and psychomotor skill testing. This search revealed that very little research has been done in the area of psychomotor achievement. Practically all of the research which has been done in this area deals with aptitude measurement. It was the opinion of the project staff that if progress were to be made in the development of performance measures which were largely psychomotor in nature, some basic questions concerning such senses as

kinesthetic, auditory and visual must be answered. Initial investigations into the components of skill development revealed that much emphasis was placed upon diagnostic ability in the various trades and technologies. This ability along with manipulative ability was viewed by many as being an important differentiating factor between "good" and "average" students. It seems evident that, in addition to intellectual capability, senses such as auditory, visual, kinesthetic and olfactory play a major role in the diagnostic process.

To facilitate development of performance tests, an experimental section was established within the project. In addition to developing items for the actual performance tests, it is the responsibility of the experimental section to conduct basic investigations concerning the above mentioned senses. From the initial investigations two of the senses which appear to be of major importance in performance were the tactile-kinesthetic and auditory senses. The majority of our basic research effort has been directed toward these two senses.

Discussions with instructors concerning manipulative skills in any of the trade areas would inevitably utilize the term "feel." Although no one could adequately verbalize what was meant by the term feel, there was unanimity that it could not be taught. It was the belief of the project staff that feel was a product of the individual subtle rearrangement of tactile-kinesthetic feedback cues. The project staff concluded that some means of measuring the tactile-kinesthetic sensitivity of people in various situations must be devised. Our literature review in the area of kinesthetic sensitivity yielded only one study which dealt with the reliability of this sense. This study dealt with the ability to discriminate between small differences in weight by lifting first one weight and then the other. Our project staff was unable to replicate this experiment with anywhere near the .85 reliability reported.

It was the opinion of the staff that if it were possible to determine the orthogonal dimensions of the tactile-kinesthetic sensitivity in arm and hand movements, it would then be possible to study what happens to this sensitivity as a function of training. This would permit the study of the hypothesis that it is primarily the input function which becomes modified during training. To achieve the objective of measuring the tactile-kinesthetic sensitivity in arm and hand movement, our technical staff designed an apparatus which allowed the measurement of tactile-kinesthetic input in three directions, vertical, horizontal, and fore and aft. As of this writing, the apparatus is in operation and the experimental staff is in the process of collecting data on numerous studies.

While the basic experimentation mentioned above was in progress, much time was also devoted to designing tactile-kinesthetic sensitivity tasks which were more directly applicable to the manipulative skills required in the trade curricula included in the project. In the areas of automobile mechanics and machinists some representative tasks which have been developed are, (a) accuracy of measurement, using precision gauge blocks, certified feeler gauges, telescoping gauges and micrometers, (b) off hand grinding test, where the subject is shown a model of a lathe tool bit and is required to grind, by hand, a $60^{o}$ threading tool, (c) four jaw chuck test, where the subject is required to true a plug in a four jaw independent chuck that is offset 1/16", (d) cumulative indexing test, where the subject using a high quality milling machine is required to move the table in and out according to a series of dimensional indexes, and (e) plug and ring gauge test, where the subject is required to place ring gauges onto two rows of precision plugs according to certain specified fits such as a "wring" or #1 fit, a "running" or #2 fit, and a "slide" or #3 fit.

Another sense to which much project research time is being devoted is auditory. The choice of the auditory sense was made on several accounts, (a) in discussions with instructors in certain areas the consensus of opinion was that the auditory sense is invaluable for diagnostic ability, (b) it is a sense which, in the opinion of the staff, could adequately be investigated within the confines of the project resources, (c) it is a sense, unlike smell, taste, temperature, etc., which could feasibly be tested outside of the laboratory situation.

The primary question to be answered here was whether certain diagnostic sounds do discriminate among students, and if so, whether this discrimination is independent of that made by paper and pencil tests.

Of the areas being studied under this grant, present indications are that auditory diagnosis is important in at least the areas of auto mechanics and machine shop.

In the automotive area, a list of abnormal sounds associated with automobile malfunctions has been made. Both normal and abnormal sounds will be employed to determine if the better students can more readily diagnose abnormal automotive sounds than can the weaker students. The project staff is now in the process of recording many of the sounds. The tape which is being produced will consist of a series of perhaps 50 to 100 sounds of malfunctioning parts of an automobile. In consultation with instructors four alternatives are being constructed for each item in the test. That is, four possible causes of such a sound will be presented to the student. The student's task will be to select from the several alternatives the one which correctly identifies the malfunction. The entire test is being recorded on tape so that the test can be administered without benefit of specially trained psychometricians. The sound will be played

back using a high fidelity tape recorder and binaural headphones for each student.

In the machinist area, many sounds of normally and abnormally operating equipment are being made to determine if the student can first ascertain which sounds are abnormal and secondly, if the sounds are abnormal can the student then identify the sounds.

Progress in the study of auditory responses has been drastically delayed due to our inability to obtain the necessary recording and playback equipment. At this point, sound recordings are being contracted out to commercial sound studios.

In addition to the work being done in the psychomotor performance area, studies such as a tool identification test, an automobile electrical system trouble shooting test and a diagnostic test utilizing an electronic engine analyzer are being developed. In the area of radio and television repair, the project has purchased a television set into which approximately 30 different malfunctions have been built. By turning on the proper switch, various malfunctions affecting the audio or the video or both can be introduced into the set. A 50 item test is under development which will utilize the malfunctions demonstrated by the television set. An alternate form of the test is also being developed which will utilize pictures of the malfunctions rather than the set itself. If the second form of the test proves to be as reliable as the first and it is determined that both tests measure essentially the same behavior, then the static form can be adopted thereby eliminating the logistics problem of carrying the television set around the country and also eliminate the possibility of malfunction in the set.

In summation, substantial progress was made during the first year of operation. The project is progressing on schedule in most areas. Development of pencil and paper measures of achievement are on schedule and progressing nicely. Several areas of performance measurement are on schedule and suitable progress is being made. In other areas of performance we are somewhat behind schedule, either because of our inability to get the proper equipment as is the case in our audio studies, or because of the need for basic research as in the case of the tactile-kinesthetic sensitivity experiments.